

MYERS

The Development of Memory Types
In School Children and the
Relation of the Various Types to the
Reproduction of Sense Material

Psychology

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1908

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The Development of Memory Types in
School Children and the Relation
of the Various Types to the
Reproduction of Sense
Material.

BY
ELMER JAMES MYERS, A. B., 1907.

Thesis for the Degree of Master of Arts
in Psychology
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THIS IS TO CERTIFY THAT THE THESIS PREPARED UNDER MY SUPERVISION BY

Elmer James Myers

ENTITLED *The Development of Memory Types in*

School Children and the Relation of the Various Types to the Reproduction of Sense Material

IS APPROVED BY ME AS FULFILLING THIS PART OF THE REQUIREMENTS FOR THE

DEGREE OF *Master of Arts*

in Psychology

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The immediate problem of this study is the development of various memory types during the school years, and the relation of the particular memory types to the retentiveness of material appealing to the various types of mind.

In this there are three distinct elements. First: Is there any one of the principal memory types, the auditory, the motor or the visual, that is particularly strong at a given stage of child's development; i. e., can a given period of a child's development be characterized by the dominance of a given memory type as the visual type for the primary grades, the auditory for the grades next higher, etc.? Second: If there is a change what is it; where does it take place and what is the cause of it? Is the cause inherent in the course of mental development or is it due to method of instruction and other external causes. Third: What is the relative efficiency of these types in retaining particular sense material? For example, where the auditory type is the stronger, is the mind more efficient in retaining auditory experiences than the motor or the visual? If so, are these advantages or disadvantages of sufficient importance to warrant a serious consideration in the study of the learning process? These considerations, together with some minor problems, constitute the subject matter for investigation.



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-method-

A method to be adequate for determining the memory type of children must be simple and yet accurate. It must be simple and easily comprehended because the experiment is to be made with inexperienced observers taken in groups, not with persons accustomed to the laboratory and familiar with the use of psychological terms. The importance of this requisite should not be over-looked as many methods for psychological investigation produce excellent results when used with trained observers but are valueless when used with children. The test must also be accurate, that is, it must be such as will indicate the actual experiences of the observer. This is especially necessary in the present experiment. An adult, who has been trained in analyzing his own experience, may be relied upon for his introspections but the same is not true with children who have had no training. This was clearly shown in a series of tests made at the beginning of this study. A series, which involved certain distractions was given to a hundred school children in the fourth and fifth grades. Together with the tests was given a list of questions inquiring concerning the effect of the distractions upon their power to memorize. Of the answers given only a little over fifty percent agreed with the actual results received from the tests. The children were not accustomed to analyzing their states of consciousness, neither did they clearly comprehend when asked concerning their experiences. Their answers were nearer their idea of what they thought was wanted than an account of their experiences. The method

used with inexperienced observers must be such that the accuracy of the test will not depend upon the observer's report of his mental states but upon the actual results of experimentation. The test itself must indicate the memory type and not the introspections of the observer.

Among the best known methods for determining memory types are; the "questionnaire method" first used by Galton; the "word method" used by Kraepelin; a modification of the "word method" used by Secor; Binet's method with the letter squares; and various forms of the "distraction method" used by Meunier and others. These are methods devised in most part for the skilled observer and not for children.

The "questionnaire method", now used extensively in some universities, places much stress on introspection. An observer is given a set of questions concerning his experiences and is requested to answer them as accurate as possible. For example, a list like the following may be given; Imagine a garden of roses. Can you get a distinct image of the flowers? Can you see all their parts? Can you get an image of the odor, feel the smoothness of the petals, hear the hum of the bees among the flowers, etc? The observer studies himself to see if he can detect the presence of these images in his experience, and his type is judged according to his report of what he discovers. There are two objections to using this method in the present experiment. First, as was suggested before, children are not capable of such accurate introspection. If such a series of questions were given a group of children and they were thorough-

ly aroused to do their best in recalling the image, it is probable that they would report in the affirmative if they thought such an answer desired. If not, they would be at a loss to know what to expect, their interest would soon be gone and the effect of the experiment would be lost. In either case there would be no way of verifying their results and the conclusion of the test would still be in question.

The second objection to the "questionnaire method", applies to the device as a method, both for the experienced and the inexperienced observer. The presence of imagery depends on different factors, such as power of stimulus, recency of the experience, repetition of the observation, etc. In the laboratory these factors are carefully noted in the conditions for experimentation. They are nearly as important as the reports of the observer. In the "questionnaire method", these factors are ignored. A set of questions is asked an observer concerning certain experience, and the one who asks them knows nothing about the time, place or conditions under which the observer came into possession of those experiences. Suppose the above list of questions were given an observer in the winter time. He had not been in a garden of roses for nearly a year where he could smell their odor, feel their petals and hear the bees. He had, however, seen such a garden every day as he passed the green house on his way to school. Under these conditions, other things being equal, the observer would report more favorable to the visual than to the auditory or olfactory types. The method may or may not be a fair test for memory type all, depending on the immediate

environment, a thing which the method leaves entirely with the observer for correction. With the youth, where vivid impressions are such factors in memory, the immediate environment is a great agent in determining the images that are most easily recalled. Hence this method is not only beyond the ability of the subjects to be tested in this experiment, but may be open to criticism as a method even if the children could report accurately concerning their experiences.

The "word method", used by Kraepelin is no less difficult for the present experiment than the questionnaire method, nor is it less free from criticism. According to this method the observer is required to write down a list of objects characterized by their color; again a list characterized by their sound, etc, it being assumed that the visually minded person would succeed better with the first test, the auditory minded with the second and so on. It would be nearly impossible to use this method with children in a place where color is everywhere to be seen. The objects given would be those of immediate vision. However, where conditions are such that the observer would be placed where objects of color could not be seen the method would still be open to the same criticism as the questionnaire method, namely, the past experiences upon which the observer must draw for his material in the experiment would not be taken into account. For instance, had the observer just visited a park or a picture gallery, he could readily name objects of color. The error is

that the method assumes a normal environment where color, sound and motion have an equal part in ones' experience, which may or may not be true.

A modification of this method was employed by Secor who presented a list of printed words to the observer, who was to note the imagery that developed in his mind as he glanced at each of the words. This is clearly a method for trained observers and not for school children. The average child could do nothing with detecting the imagery developed from the sight of a meaningless syllable. In most cases no answers would be given, and where introspections were made they would be open to question.

Binet used the letter squares in which, for example, twelve letters of the alphabet were arranged as follows:

P X K B

Y Q H A

F T C V

The observer, after looking at the letter squares for ten seconds, laid it down and attempted to reproduce it from memory, his type of imagery being determined by his introspection. The first part of the method, the reproduction of the letter square, suggests a valuable test for visual memory. Especially is this true in testing the observers sense of position for the various letters. A modification of this method was used as a test for visual memory in the series finally adopted for this experiment. (See tests Nos. II and III page 44.)

In connection with this method Binet employed another test to detect the motor type. To impede the motor imagery arising

from the mouth, he had the observer hold the tongue between the teeth both while memorizing the syllables and while writing them. This was not intended to eliminate motor impressions entirely, but to so impede them that the loss would be quite noticeable if the observer were strongly of the motor type. The loss due to eliminating the motor element could readily be seen by comparing the results of this test with a previous one in which the tongue was free. The method has many advantages over other methods in determining motor memory especially with children. The distraction method used by Meumann, a method in which motor memory is eliminated by having the observer sing or repeat the letters of the alphabet while memorizing the syllables, is too difficult for the average child. Few persons can divide their attention so as to repeat the letters of the alphabet and memorize syllables at the same time. To obviate this difficulty the advocates of this method contend that by constant practice, the repetition of the syllables would become almost automatic thus eliminating much of the distraction. This may be true with the trained observer, but it is too much to be expected from a group of children. This test was attempted with a class of fifty, by having them sing the syllable la, while memorizing ten syllables. The distraction caused by the noise and the division of attention was so great that the results could not be relied upon. Binet's method has the advantage in that there is no noise and there is but one thing to attend to.

In planning the series of tests that was finally used for

this experiment, other methods were discussed. One was the recognition of angles as a test for visual memory. According to this plan a series of angles would be exposed for the observer to fix in mind. Afterwards, in a promiscuous set of angles, he would be expected to recognize the angles seen on the screen and indicate them by number. The plan assumed that the person having the most distinct image would most readily recognize the angles on the card. A similar plan was to have a series of letters placed at special angles and then exposed to the observer. After exposing the screen ten seconds the observer was to put the proper letters in angles which were arranged on a card before him. From these two suggestions came test No. 1 in the series of tests for visual imagery.

Another test suggested for visual memory was to expose some nonsense characters or foreign symbols, such as Hebrew letters, and have the observer reproduce the same from memory. The type would be determined by accuracy of reproduction. The objection to this plan was that the characters being exposed for some time would probably suggest names, and thus the results would be those from auditory and verbal memory, as well as from the visual types. This, however, suggested the nonsense characters, which combined with the idea of spatial relations formed another test of the series for visual memory. (See test No. 2 page 44)

Various other methods for detecting different types of memory were devised, discussed and modified, which together with those described, resulted in the series of seven tests for memory imagery which was used in this study.

-Tests-

For convenience, the series of tests were divided into two groups. The first group was composed of three tests each of which was intended to appeal to visual memory. They were composed of characters and spatial relations which eliminated as far as possible any aid from auditory or motor centers. The second group contained five tests in which nonsense syllables were used. These syllables were memorized by visual, auditory and motor methods. The tests with their description were as follows:

Test No. 1. The children were seated at their desks in an easy position with pencil and paper. On the paper was a series of four letters duplicated five times. They were arranged in promiscuous order in four lines of five letters in a line. (See figure 1 a). On a screen 22 x 28 inches there were two lines intersecting at right angles forming four angles. (See figure 1 b.). In these angles were placed the four letters found duplicated on the papers that were in the hands of the children. The test was to see who could put the proper angles around the largest number of letters taken in order as they appeared on the paper in a given period of time. The proper angle was the angle in which the letter was found on the screen. After careful instruction, the screen was exposed to view twenty seconds. As soon as the screen was removed, thirty seconds were given for placing the angles around the letters.

The assumption in using this test was that the strongly visually minded person would carry the image of the relationship between letter and angle with him and that consequently as soon as he saw a letter he would also see the angle it was in from the mental picture. This would give him a decided advantage, and, other things being equal, his power of visualization could be estimated from his speed and accuracy in placing the angles. This test worked fairly well in the more advanced grades but was in general too difficult for smaller pupils. There was a decided advantage in favor of the rapid working pupil, since speed was largely the standard of judgment, so that often a person might be classed as visual from the results when his success was due to a larger extent, to his rapidity of movement and not to the advantage gained from carrying the image with him.

Test No. 2. In the second test, the children were given pieces of paper on which were four right angles with sides respectively parallel and with convenient distances between them. (See Fig. 2 a.) This served as a device used for the correct placing of characters. On a screen 22 x 28 inches was a similar figure and in each of these angles and spaces were meaningless characters. (See Fig. 2 b.) These characters were used because they appealed to the eye and at the same time did not readily appeal to the auditory, motor and verbal memory. The screen was exposed five seconds after which the pupils

were to reproduce these characters putting them in their proper place. In other words, the pupils were to make their paper look like the screen. The short time of exposition allowed very few to associate names with the characters, not more than one in five according to introspections, that they gave in answer to questions concerning their naming the characters. This test on account of its simplicity and ease of grasp, was of especial value to the children of the lower grade. It was a test which appealed to all alike and there was no misunderstanding as to what was expected. In recording the results, three different methods of estimating their accuracy were employed; one on the numbers of characters attempted, one on the number of correct characters, and a third on the number correctly placed.

Test No. 3. The third test of this group was similar to the second. The pupils were provided with papers ruled like the first. This time a screen was exposed which had letters and figures in the spaces instead of nonsense material. These characters were employed that all might have the use of sense symbols. These letters and figures were of different forms. Some letters were capitals, some were small, some were script and some were printed. The figures were Roman and Arabic and all characters had a specific place. Ten seconds was given to look at the screen, after which thirty seconds were given for reproduction.

This test, though more complex, was used as a complement to the second test. In the first test no one was supposed

to name the characters though there was nothing to prevent some name being attached to them. In this test, all the characters had names familiar to all. In this respect larger advantages were allowed for the introduction of the auditory-motor and verbal elements than in the former. However, the principal appeal was to vision. The letters were black, bold and of different size, while the angles were red as was the case in the former test. The form and the spatial relation were the dominating elements considered. There were three grades given, one grade on the number of characters correct, one grade on the number of characters having the exact form in which they were written and a third grade on position. By a comparison of the results here obtained with those of the second test, a fair idea of a person's visual powers might be had.

In the second group of the series, five tests in number, nonsense syllables were used. The results of this group were quite satisfactory. The tests were clear, easily understood and but slightly different from the regular school work. The following are the tests of this group given in their respective order, but numbered as they occurred, in the series.

Test No. 4. Upon a piece of white cardboard, eight by twenty inches, was placed, one above the other, a row of six nonsense syllables. These syllables were composed of three letters (two consonants and a vowel) and were made of black gummed letters, one and one-fourth inches high. The children

were seated at their desks with pencil and paper. Upon a given signal the screen was exposed and twenty seconds was given to commit the syllables. At the close of twenty seconds the screen was removed and the children asked to write the syllables. As this was the first test with nonsense syllables, it was after a few moments repeated with different syllables, and the average of the two was taken as the initial test for the group.

Test No. 5. In the fifth test a screen similar to the fourth was used but with different syllables. The only difference was in the manner of memorizing. As soon as the screen was exposed the children took the blunt end of their pencil and wrote the syllables on their desk once. After this they were allowed the remainder of the twenty seconds to memorize the syllables as they chose. Thus the difference between test No. 4 and test No. 5. consisted in the addition of the motor sense, involved in writing the syllables. By comparing the two tests, some indication of the motor memory for the fore-arm was given, but not necessarily for other parts of the body.

Test No. 6. After a rest from the first two tests, a third was given. The conditions were the same as in No. 4 and No. 5, and the same test was used only with different syllables. This test was to determine the value of the movements of the lips, tongue and throat to the memory. In test No. 4, which was used as the standard, these organs were allowed absolute freedom in the process of memorizing. In test No. 5 these

movements were impeded by catching the tongue between the teeth and holding it there during the test. Care was taken that the tongue was well extended and held both while learning and writing, so that there was little aid from this source. This method did not completely inhibit motor sensations from the mouth, but it did so impede them that any one strongly dependent on these sensations as an aid to memory could be readily detected. The results from this test compared with those of the initial test gave evidence of the extent to which the memory was aided by motor sensations. Hence the amount of the motor type found in any grade would be in proportion to the decline of the memory curve caused by the elimination of these sensations.

Test No. 7. The seventh test was intended to appeal to the auditory type. While it is by no means certain that a person will employ auditory imagery in remembering syllables by sound, (it being quite possible for him to translate them directly into motor or visual symbols), it is fair to assume that the person who is distinctly of visual type will be somewhat at a disadvantage in remembering material thus presented. For persons of the motor type, the disadvantage will not be so great; still the distinctively auditory type should succeed better than the motor in such a test. The six nonsense syllables were used as before, but this time were read and not exposed to vision. These syllables were pronounced and spelled slowly and distinctly to the pupils and then repeated. This

took twenty seconds, the time of the other tests of this group of the series. At the close of the second reading the syllables were reproduced. Here the visual element was at the minimum and the auditory at the maximum. By the use of a series of tests that appeal to different memory types, it is probable that where one type is particularly prominent, it will be shown in a comparison of the results of the tests.

An outline of the manner of determining the memory type by the use of this series may be briefly stated, as follows; In tests No. I, II and III, visual memory is ^{appealed to} ~~exposed~~. In test No. I the visually minded person has the advantage in placing the proper angles around the series of letters, and, other things being equal, the power of visualization is shown by the speed and accuracy of the production. Test No. 2, with the nonsense characters, appeal strongly to visual memory and the visual type is exposed by accuracy both in the reproduction of the characters and in their spatial relations. In test No. 3. visualization holds a strong place, yet the auditory and motor powers may be important factors in determining the results. The phase of this test that indicates visual memory is accuracy in character-*forms* and in spatial relations. By a comparison of the results of these three tests, visual memory can be detected where it exists in any degree of prominence. An estimate of the effectiveness of muscular impressions from the fore-arm is made by a comparison of the results from test No. 4. with those of No. 5. These tests are alike except that in the

former the muscles of the fore-arm are not used, while in the latter they are. The difference in the two results indicates the relative effectiveness of motor imagery from the arm. Test No. 6 is like test No. 4 except in test No. 6 the motor impressions from the mouth are eliminated. The effect of motor imagery is shown by the inverse ratio of the result of these two tests. Likewise a comparison of the results of tests No. 4 and No. 7 shows the relative value of auditory imagery, but not in inverse ratio. Thus the classification depends entirely on a comparison of results of distinct tests that appeal to the different memory types. The emphasis is placed on the judgment of the one performing the experiment rather than on the introspections of the observers.

As a series of tests there is no claim for it as having superior excellence, though it is claimed that a series is better than a single test to determine memory type. It is in itself an experiment, but judged from the present trial, it seems to meet the requirements needed for a general exploration of the field of memory development, for which it was devised. Were the series to be given again, perhaps test No. 1 would be eliminated and the series would be repeated. Test No. 1 would not be discarded, because of defects of it as a test, but more because it did not represent tangible results in such a general investigation. It is worthy of a trial in a more minute test where greater care can be taken, closer observation of pupils made, more careful introspections recorded and greater accuracy demanded.

This series of tests outlined above was given in the schools of Champaign, Illinois, and in the University of Illinois, in the spring of 1907. They were all given in the same period of the day, from 9:00 A. M. to 11:30 A. M., and under similar conditions. This period of the day was selected because it was considered the best period to ^{Produce} the best results. It is the time when the children are least fatigued and most liable to put forth their best efforts. The tests were given to the pupils in their own rooms in the school building. The conditions of the rooms were much the same. All were neat, well lighted and ventilated, well governed and had from thirty to forty pupils in a room.

In making the investigation, two things were guarded against. First, care was taken that no suggestions or helps should be given unintentionally by the person giving the test; and second, that the pupils should not be fatigued. To avoid errors that might arise from these two sources the writer gave the tests alone without assistance from the teachers. To overcome the danger of timidity on the part of the pupils, a few moments were taken in which the experimenter sought to gain their confidence.

The condition sought was such a one as would insure the maximum effort from all. The room was closely watched and in case a pupil did not try, or received help, which was rare, his paper was quietly discarded. Fatigue did not seem to be a problem, especially in the lower grades. The tests were alternated, those of vision with those of the syllables, so that they

were not tiresome.

VARIATION OF THE MEMORY TYPE.

The results represent averages of returns from seven hundred and fifty persons, one hundred in each of the grades from the fourth to the eighth, fifty in each of the grades of the high school and seventy-five persons in the University. They are arranged in ways that will best show their significance. However, many of the most convincing evidences, either for or against a certain type are not shown in figures but were noted by the observer as he conducted the investigation.

The first significant thing noticed in the results is the apparently early maturity of the visual type. In Fig. No. 4 the results of tests No. 2 and No. 3 were averaged together since they both refer strongly to visual memory. The results of the four tests that appeal strongly to the four types of mind are plotted as they were made in the various grades. Two school grades are averaged together since it shows better the general trend of the different types. Beginning in the fourth grades, with an average of 73% the tests that appeal almost exclusively to vision continue with little variation through the University finally ending two percent better than at the beginning. This maturity of vision is plainly shown in tests involving accurate visual perception. The low grades in test No. 2 were usually due to omission of characters there being few that were of wrong form or wrongly placed. In the third test where letters and figures and grades were made on

proper form and placement, the fourth grade made 84% and 88% respectively in form and place, while the University students received 91%. While the latter got 74% of the letters and figures correct against 71% in the former. The evidence of the keenness of visual imagination is further seen in the third test. In the higher grades, an attempt was frequently made to assign names to the meaningless characters, a thing reported less often in the lower. In the fourth grade thirteen percent of the pupils reported in their introspection that they had attempted to name the characters, while in the seventh grade there were thirty-five out of a hundred. Introspections were not taken on this test in the University.

Not only is visual memory keen in early years, but it is also more persistent. This fact is not new. The child's memory of what he sees is almost proverbial. This was strikingly shown in a few tests that were taken as a subsidiary problem in visual perception. Test. No. 2 was reproduced in a few of the lower grades a day later without a second exposure of the screen. In a room of forty pupils in the fourth grade, after an intervention of one day, only six showed a loss in memory, while thirteen raised their grade of the day before and the entire room raised the average grade from seventy-two to seventy-nine percent. (This rise in the memory curve after a short lapse of time seems not uncommon to visual memory, a thing to be discussed later.) This type of memory seems as

efficient in retaining its impressions as in later years. It will be seen in the consideration of the fading of the memory image that in the lower grades this type is quite efficient in retaining visual imagery, showing that the visual type is well developed in early life. While visual concrete imagery is strong in the lower grades, verbal imagery seems in part to take its place in the more developed mind. The verbal mind is strong when it can give a name to the characters presented to it, but where this is difficult as in the nonsense characters, this type of imagery seems baffled. Hence, the lower grades grasped and retained the nonsense characters readily but showed difficulty in retaining the syllables or the characters in the complicated test No. 4. where characters, names and forms were all involved. The fourth grade made an average of seventy-six percent in test No. 2., while it made only seventy percent with the letters and figures in test No. 3., and only eighty-eight percent of those were of proper form and eighty-four percent in proper places. The individual test shows this difference ever more plainly than the general average. Quite frequently was it the case that nearly all the nonsense characters were correct and correctly placed while a very poor showing was made with the letters and figures. The same thing is seen in the syllables. The average is low as compared with the concrete visual image. The mind in this case was not helped by association but retained the image of the object. The reverse is true of the adult mind. The mind holds by association. In the test with the nonsense syllables the

average made by the university students was the same as that made with the nonsense characters sixty-six percent, while in the fourth grade the average was forty-three percent in the former against seventy-six percent in the latter. There was also an increase in accuracy in test No. 3. as compared with No. 2. There was a falling off in the University in the nonsense characters (test No. 2), while in the test with the letters (test No. 3) there was a gain of four percent and a gain of five percent in correct form and place. Again there was a stronger effort made to name these nonsense characters by the students. In the fourth grade not more than one sixth made any attempt at naming them, while in the eighth grade there were a third. This same tendency of the developed mind to retain only those things it can associate in its experience was seen in the story. ~~In this test the auditory type was the strongest in the University students, but the visual element predominates in that grade by eight per cent.~~ Nothing shows this more plainly than a comparison of the grades of a single individual in different tests. For instance it is no uncommon occurrence to find a grade of fifty or sixty percent in the nonsense characters made by the student of the high school or university and a hundred percent where the letters are used. This goes to show that the mind has become accustomed to hold those things it can relate and name. These it can retain, but concrete images are held with difficulty.

The auditory type seems to approach maturity later in life, than does the visual. In this type there is a more gradual development, beginning at a comparatively low stage in the fourth grade. Fig. 4 shows the auditory type beginning in the fourth grade with an average of forty-five percent and taking a gradual but rapid rise through the grades to the high school, through which it takes a more even course at about seventy percent and closing in the university at seventy-seven per cent, the highest grade reached in average results. The rise in the memory curve of the auditory type is the most constant of the three types.

These results are not the only ones that show that the auditory power is not as fully developed in the lower grades as is the visual, but general indications point that way. Both the story and a test for persistency in auditory memory similar to the one in visual, show that the retentive power of the mind for auditory images is weak.* This was also noticed in the expression of the children as they tried to grasp the syllables read. They seemed to seek for something they could not grasp. The auditory type seems to reach its first high level in the ninth grade. Here it remains until it gets an extra stimulus in the university, where it reaches its maximum.

That the auditory memory should develop later in life than the visual should not be wondered at. After the child does begin to hear and take notice of things heard, the eyes are used

* See Appendix. *w*

many times while the ears are used once. There is a constant field for the eye but the auditory impressions are more rare. From the fourth to the seventh or eighth years in school is a period for auditory awakening. The child listens now and sees less. He is constantly with companions. His lessons are largely oral and his studying is often accompanied by the whisper. In the high school there is little change of method of instruction and of surroundings. The change in the University may be accounted for by the change of method of instruction. Here the lecture method is largely used and the visual powers neglected. Thus there seems a harmony between the actual change in this type and what might be expected from the manner of development.

The results from the motor tests were somewhat different from what might be expected from children in the lower grades. This is the time when the lips are exceedingly active. In the tests at this period action was strongly manifest. There were scarcely any children that did not move their lips and muscular movements of the entire body were not infrequent, especially when interest was great. Contrary to what was expected, the results showed little assistance to the memory from motor activity. This was especially true in test No. 3. in which the motor activity from the arm was tested. The fourth and fifth grades alike show a low grade but a comparatively rapid rise about the sixth. From the sixth to the ninth there seems little change but from thence there is a gradual rise, the maximum being reached in the tenth and in the university.

In the individual tests about forty-five percent of the pupils of the fourth and fifth grades showed strong motor type, (not always predominating) seventy percent in the seventh and eighth grades and eighty percent in the high school. Hence it seems motor memory is of later development than the visual, and the motor impressions are not of so much consequence in the lower grades as may be expected from appearances.

This conclusion is also sustained by the results from test No. 4., in which motor impressions from the mouth were impeded. In all the grades below the high school the lips were almost invariably used in memorizing syllables. So conspicuous and so common is this practice that it has been urged by educators, that there is a strong loss of the mental power by inhibiting lip movement during study. Scarcely were there ever more than three or four out of a room that did not move their lips in the course of a test with syllables. yet the results from test No. 5 showed that both the inhibition of these sensations and the distraction caused by holding the tongue between the teeth seldom amounted to more than five or ten percent, and it is probable that distraction was the cause of most of that. This does not mean that the interest in motion is not great, for it will be seen that it is. It means that the actual assistance the mind received from the motor sensations in the early period is not great. They are often over-estimated. Thus it may be seen that the motor impressions are not used early as an aid to memory. While the child moves much,

the movements are not such as to be of value to the memory process. The child writes comparatively little before the sixth grade, and the use of the lips as a means of fixing impressions on the mind is probably more or less automatic.

Other motor responses accompanying the learning process are general in character and so many and so diverse that the mind loses sight of them as a means of assistance. About the sixth grade, writing becomes of so much importance both on account of the amount done and of the newness of it, that it readily affects the memory curve of the motor type. The additional rise in the high school and in the University is not more than could be expected from the amount of writing especially in connection with note taking as is required there.

Thus in the development of the memory process, it seems that the visual type holds a strong dominance over the other types until about the seventh or eighth grades. (Heumann E., (Ueber Ökonomie und Technik des Lernens. Die Deutsche Schule, Vol. 71) points out that children are more predominately visual and less acoustic-motor than adults. It has been quite generally observed that while children depend on concrete imagery, adults think more predominately in what is termed "inner-speech"; in other words in acoustic-motor symbols. (verbal imagery.)

At this period the auditory type, which begins at a low stage in the fourth grade rises to the level of the visual

type and is its rival throughout the high school finally ending in the university with a margin. The visual type shows only a little change in efficiency in retaining concrete visual percepts. The type changes, however, from the concrete mechanical type in the lower grades to a rational apperceptive type in the later years. This change is gradual, the most rapid change taking place in the sixth and seventh grades which seems rather a transition stage in child development. This rational visual type continues its development through the high school and the university where it is perhaps the dominant type. The motor type beginning in the fourth grade on the equal with the auditory, rises more slowly and gradually. There is a sudden rise ^{in memory} in the effectiveness of the motor sense from the ~~arm~~ ~~to~~ ~~the~~ ~~memory~~ about the sixth grade from which time the development is gradual ^{as it is} with the other types. The loss caused by the elimination of the motor impressions from the mouth was not great. The memory curve from this test is about five percent below the standard test No. 4., throughout all grades, showing that this loss is due largely to distraction caused by the unnatural position of the mouth. There seems a gradual development of the verbal type with advancement of years without the characteristic rapidity of rise about the sixth grade as is seen in the auditory and motor types. The results from this type, however, are suggestive more than conclusive.

These results show the way the mind develops rather than

the cause for the particular tendencies. Evidences are, however, that the training has much to do with the development of particular types of mind. In the third and **fourth** grades the types were more distinctly marked. There were much wider individual differences in the results of tests. In these lower grades there is extreme variety in results, which is not so marked in the higher grades. While vision holds the predominance over other types, yet it was not an infrequent occurrence to find a person who showed very strong auditory-motor type with poor visual powers. The mind has been free to develop according to its natural tendencies. The circumstance that the visual power is strong at first is due to its being the first type of imagery to be effectively used and in the earlier years, it is constantly being developed. In these early stages the vision seems the natural avenue for gathering information and thus it has the advantage in the outset which is shown in the early years of school life. From the fourth grade on to the eighth there is a tendency toward what might be called a balanced type in which the four types are more on a level. The visual type decreases slightly in its effectiveness, while there is a rapid development in the motor and auditory types about the fifth and sixth grades. The change may have started in the lower grades, but this study has not sufficient data from those grades to show whether this be a fact. As has been said above, this is a time when there is a decided change in a child's

development. His attention is somewhat taken from visual objects and centered on reading and writing, the auditory and the motor side. A similar change, but not so marked, is seen in the ninth and tenth grades and also in the University but in a less marked degree.

In the fourth, fifth and sixth grades, especially in the last two, there seems a strong tendency for the child to attempt to employ his motor impressions to assist in memory. To do this he does not depend much on particular muscle sensations, but all the body seems to be active. When intensely interested he moves his arms, twists in his seat, strikes his fist into the palm of his hand, shifts his feet and goes through a variety of other movements, but does not use his pencil. No doubt he tries to bring these movements, which he has learned in a general way, into co-ordination with his visual powers, but only in the most indefinite way. The muscles of the fingers are not used, as in the higher grades. These finger movements are of no great assistance as is shown in test five. It is quite probable, however, that if all the random movements had a direct bearing on the material in hand they would be of much value, but they are too general to be effective to any great extent.

Having traced in general the development of memory during the school years, we may now turn to the second consideration of the present investigation. It deals with a subject that has been dealt with before in a general way by those studying pedagogical problems, namely the fading of the memory

image. The present problem, however, has as its aim not merely the fading of the memory image, but also the fading of the image of the various types of mind, especially as related to the particular sense material memorized. We may ask the question, Does the auditory type of mind tend to retain auditory material better than material appealing to another type, for example, the visual type? Does the visual type retain better visual material, or are there other forces that play a part in memory so that a distinctive type may not necessarily retain material of its kind?

The series of tests dealt for the most part with simple material largely without meaning. The matter of interest was eliminated, association was reduced in effectiveness; in brief, the mind was studied in its reaction to simple stimuli appealing to individual mental types. The test now to be considered employed sense material which appealed to interest and involved associations of considerable significance and complexity.

This test was presented in the form of a story which was constructed with the purpose of appealing in its various parts to the three chief types of imagery! *This story is given in the appendix, see page* ~~The following was the story used; story was omitted but will be given. (overlooked)~~

The story was written to appeal to the interest of pupils of all grades. The first part of the story was devised to arouse auditory imagery; the second, motor, and the last, visual. Motor imagery is also involved in the last few lines.

The three types of imagery were of about equal importance in the story, there being fifteen suggestions of images of each type. The story proved well balanced and was apparently of equal interest to all. The test with the story was carried out under similar conditions to those under which the first series of tests were conducted. It was in the same rooms with the same pupils and at the same time of day. The parts of the story appealing to different types were emphasized with equal prominence. No comment was made on the story and no explanation made. The pupils were told the story was to be read to them and after it was finished they were to reproduce it telling everything that was in it.

Immediately after the story was read the pupils wrote it out on the paper that had been previously provided them. The papers were collected, marked and filed. The next day at the same time, a second reproduction of the story was taken. There had been no previous warning that this was to take place, nor were there any suggestions given concerning the story, except that each one was to write out everything he could remember of the story of the day before. These papers were likewise filed away for grading. Two weeks later, at the same time of the day, a third reproduction was taken in the same manner, thus giving the results of the memory at three periods, one immediately after the story was read, one a day later and the third after an interval of two weeks.

Only a few of the papers, however, were received from the high school and the University on account of the closing of school.

These papers were graded and the grades recorded in a manner similar to that used in the first series of tests. Each set of papers was graded separately and afterwards were re-arranged so that the papers from each person were together and the grades recorded. The papers were graded on a scale of ninety. Each paper had three distinct grades, one on the part pertaining to visual memory, one on the auditory and one on the motor. The scale of ninety was used for convenience, there being fifteen suggestions appealing to each type and each worth six percent. In grading the papers nothing but accurate results was considered satisfactory. In Fig. is a tabulation of the results of the reproduction of the story made by the grades below the high school and in Fig. of the high school and University. These are the results of the total averages made by the respective grades, giving results of the memory efficiency immediately after the reading, a day later and two weeks later.

By a comparison of the results of the tests, as is shown in Fig. 4 with the results from the story shown in Fig. 5., it will be seen that there is a marked difference in the action of the mind on different data. In the first series of tests there was a strong dominance of the visual type in the lower grades. This type was almost as strong in the lower

grades as in the upper; it was from twenty to thirty percent stronger than the other types in the fourth and fifth grades, and the retentive powers of these images was exceptionally good. This visual imagery was of the perceptive type and not the apperceptive. The mind retains the image of the object presented without the aid of the auditory or other elements. In the results with the story the reverse is true. The visual power, or more properly speaking, the visualizing powers, are weak in the lower grades while the motor is strong. The motor type begins in the fourth grade with twenty percent higher average than the visual and auditory and is not equalled by any other type till the eighth grade. The visual and the auditory types are on the same level, till about this grade, when the former gains a slight dominance over the latter and continues to be the leading type thereafter. But there can be no doubt as to the strength of the motor type in the early years in retaining motor imagery of the story. Judged on the same basis with the other types in the fourth and fifth grades, eighty percent of the persons of the fourth and fifth grades would be of the motor type and the other twenty percent would be divided almost equally between the auditory and visual types. The visual element of the story which held the lowest place in the fourth and fifth grades holds the predominant place over the other two types after the eighth with a margin of from five to ten percent. This was not true in the case of the first series of tests. In the high school

and the University there was a close rival among the three types and only in the twelfth grade was the visual superior. There was not that unquestioned superiority of the visual type as is seen in the story.

This difference of these results from the lower grades may be explained in one of two ways, or by a combination of the two. First, the prominence of the motor type in the story is due to interest and the fall of the visual is due to the lack of ability of the mind to translate the auditory suggestions of visual imagery as read into the real image. (This agrees in general with the results obtained by Colvin and Meyers in *Ped. Sem.* Vol. 13 pp. 84-93. The averages for the entire eight years of the grades showed motor imagery to be but slightly inferior to auditory and visual. It, however, reaches its height just before the high school age and then rapidly falls off.) It was noted in the first series of tests that the dominant type, the visual, retained its image long and even a day later was the visual image more accurate than a few moments after the removal of the screen. The motor image fades rapidly. There is a decrease in the memory curve of from six to ten percent in the grades below the eighth, the first day and a similar decrease below the seventh grade during the following period of two weeks. This is not found true in auditory element nor is it true in the motor in the high school and the University. There the difference is less marked, there

being a variation of but a few percent.

The dominance of the visual type in the reproduction of the story is due perhaps to a different type of visual imagery in the adult mind. The type found strongly prevalent in the lower grades was perceptual while that in later grades is of the apperceptive type. The adult mind readily translates the auditory-suggested image into a real visual image and by the aid of association it firmly fixes the image in the mind. That association is strong in the higher grades is seen in the strong tendency toward naming the nonsense characters in test three. There was also a stronger tendency to associate the nonsense syllables with words of meaning in the higher grades, as was shown by introspection. Such syllables as "fab" and "gox" were related with fad and box. The mind at this stage seems to seek for things of meaning, while in the lower grade the concrete images were retained. The different type of imagery is perhaps, due to the different type of mind. The adult mind is a mind of associations. It sees partially and by the process of association the remainder of the meaning is read into the object perceived. It images and associates images. It is constructive more than receptive. The latter power may have been lost to some extent from lack of use. Hence, in the high school and University, when the visual imagery suggested elements that could be readily fitted into past experience, the mind visualized them and held them with greater ease than it did the other types,

a thing that the lower grades could not do. On the other hand, when the concrete visual image with fewer possibilities of association was presented, the developed mind was at a loss in grasping it while the mature mind held it easily. Thus the mind seems to have different habits in retaining impressions in youth and in maturity.

The primary purpose in the use of the story was to determine the attitude of a particular type of mind toward other types of imagery. If in a certain period of life a certain memory type dominates, is it true that the mind will retain imagery peculiar to that type more readily and more persistently than imagery of another type and if so, become accustomed to perceiving and associating.

In Fig. I-IX is tabulated the results of the reaction of the three different types of mind to the different elements of the story, and also the results taken a day later and those two weeks later. By the series of tests, the pupils of each grade were classified according to their predominant memory type into the three groups, the auditory, the motor, and the visual type. Since they separated each grade into three groups and these of unequal size varying as one grade was strongly of one type or the other, some groups were small. For this reason the successive grades above the fourth were combined into groups of two grades each so that each marking represents the average of the results of two school grades, as fifth and sixth, seventh and eighth indicated by the small

figures at the top of each figure. In the upper left hand corner is the type and also the time at which the results were taken, while on the three curves is found the name of the type tabulated. The results taken two weeks after the story was read were not so satisfactory as those taken the first and second day because it was so near the close of school when they were taken. In some of the grades and the high school especially, some of the pupils were taking examinations, when the results were taken. This will explain some of the variations in those later results.

By a comparison of these results there will be seen a relation between the memory type as was determined by the test and the memory material retained in the story, yet perhaps not as strong as would be expected. The persistency of the different types for their respective imagery is more marked. There is a dominance of the motor element of the story reproduced by all the types in the lower grades. This is due, no doubt, to the strong interest of the lower grades of the motor element of the story, and not to its peculiar adaptability to the memory type. The visual type shows a strong preference for the visual imagery of the story, so much that in the fifth and sixth grades, the record exceeds that of the motor type a thing far from being true in the auditory and motor types. The auditory and motor types show a striking resemblance in the grades and in the University. (It is doubtless true that there is a much closer relation between the auditory and motor types than between the visual

and the auditory, or the visual and the motor.) There were so few of the purely motor type in the high school that the results were more nearly individual tests than average grades.

The fidelity of the memory image appears greatest in the different types for their respective type of imagery in the story, the most marked, however, is the visual. In the reproduction of the story the second day there is an increase in the average of the visual type in the grades, from the seventh to the twelfth, but this is not true of the other two types. The same thing can be seen in the action of the auditory type toward auditory imagery and the same with the motor type. The last two types are somewhat less marked, yet the same thing is true, generally, of them. The same result is seen in all the types in their reproductions two weeks later though in this instance, the motor element seems more strongly dominant with the auditory and motor type than the visual. The motor element, in the longer time seems to have a greater persistency than the auditory or the visual. The results from this part of the investigation seem more or less fragmentary since the breaking up of grades into types often leaves the number of persons in one type of a grade small while in another type of the same grade, they are very large. The results as indicated seem to warrant the assumption of a relation somewhat close between the actual mental type and the retention of the material. As all persons do not act along

the line of least resistance so the mind seems to act at times against its natural inclinations. It is highly probable that the matter of interest is of as much force in determining memory efficiency as the natural inclination of the mind.

This clearly seen in a comparison of the results of the series and the results from the story. The former, where interest was of minor importance, showed a strong prevalence of the visual type in the lower grades. In the reproduction of the story, where interest was a factor, the motor was strongly dominant. Even among the visual type the motor element of the story was quite prominent.

The general results of the investigation may be stated as follows: First there is a great difference between a test for imagery and a test for interest. It was clearly manifest in the returns from the series of tests and from introspections and observations that in the lower grades the visual type was strongly dominant. No less clearly did the returns from the reproduction of the story show a strong dominance of the motor. In the latter case the element of interest was present.

The children of the lower grades were interested in movement while their type was really visual. The power of the two elements, that of interest and that of natural aptitude of the mind, seem about equally balanced in the lower grade.

Second: There is a change in the memory type. Beginning with the lower grades the type of imagery is strongly visual.

This type is perceptual visual. It tends to retain the correct image as it is presented through the visual organs. At the same period the auditory type is much less noticeable, while the motor type, though the child seems full of movements, is not conspicuous as an agent of memory. There is a transition period about the fifth, sixth and seventh grades in which there is apparently a rapid shift of type. In this period the visual type changes little but there is quite a rapid rise in the auditory type and a much more noticeable one in the motor. The child seems to have so organized himself that his motor tendencies have become forces for memory. In the high school there is an even and gradual development of all the types, the visual having changed from the perceiving type to the apperceiving type. The University students show a comparatively even type with but little preference given to the visual. The auditory and the motor type (i. e. the arm-motor, the motor impressions from the vocal organs being mostly eliminated) have made a slight gain on the visual beyond the eighth grade and especially beyond the high school years until they rank nearly equal in efficiency with vision. There is also noticed a gradual development of the verbal type from slight beginnings in the early grades to a strong element in the University. While this type was not so thoroughly worked out by a comparison of the tests, its development could clearly be seen.

Third: A mind will tend to select and retain imagery best that appeals to the dominating memory type, other things being equal. The memory type seems almost as strong a force in determining memory as interest. Not only does the mind remember imagery the best that agrees with the memory type but it also retains it the longest. This was seen to be true in all the types to a greater or less extent and would perhaps be more noticeable were the matter traced more accurately.

Fourth; The memory types seem capable of being developed by the environment. (Meumann, E., Meber *Ökonomie und Technik des Lernens. Die Deutsche Schule*, 1903, Vol. 7, advocates specific memory training in the schools, as he believes that memory types may be cultivated to a marked degree by methods of instruction.) The dominance of the visual type in the lower grades may be accounted for by the fact that the eye is the organ of sense chiefly employed in childhood. There is a rapid development in the auditory and motor types from the fourth to the seventh grades, which is probably due to the new environment of the child and his training. The development of auditory imagery and the arm-motor imagery not unlikely is due to the chanced nature of the school work. There is a seeming break about the time of entering high school and also the same upon the entry of college and the change is what may be expected from the different mode of instruction. (See Colvin & Meyer, *Ped. Sem. Vol. 13* Netschajeff (*Experimentelle Untersuch-*

ungen über die Gedächtnisentwicklung bei Schulkindern, Zeitschrift f. Psy. u. Physiol. d. Sinnesorgane, 1900, Vol. 34 pp, 321-351) likewise found that there is an arrest in memory capacity at puberty.) At the beginning of the high school year the auditory and motor types were a little below the visual type which relation was kept throughout the four years in high school. In the University there was an additional rise in the auditory types and the verbal type was much more noticeable than in the grades. Observations incidental to the investigation strengthened the view that the change in mental imagery is largely a matter of school environment. Rooms of the same grade seemed to differ in type. As far as could be observed the difference in type was due largely to difference in instruction. Especially was this true where much of the work was oral.

There are two or three things that were watched with interest in the progress of the investigation, but were hardly in the reach of the present problem. They appeared in connection with experiment but were as by-products of the research. They have been mentioned incidentally before. There was noticed in about the fourth and fifth grades a decided tendency to action. Especially was it true when the meaningless characters were presented. The body would twist, movements were made in the air with the hand and various contortions were gone through as if the pupil were trying to adjust the body to the thing presented. It seems a period of excess muscular adjustment in which the muscular element is becoming utilized in the memory process.

Yet the motor impressions do not seem of much value to the memory. While the mouth was used almost invariably in memorizing of the syllables, it seemed rather an automatic action and its inhibition detracted but little from the efficiency of the memory, and this was doubtless due more to distraction from holding the tongue than from the loss of the motor impression.

A thing of most interest was the rise of the memory curve after a short lapse of time. It was first noticed in the reproduction of the meaningless characters in test two, when on the following day without seeing the screen, the pupils reproduced the characters with greater accuracy by five percent than were able to immediately after the test was given. The same thing was seen throughout the story. The second day the results are almost as good as the first in the strong types. This was most marked in the visual type, which was largely the predominating one. The same was seen in the other types where they were dominant. Just where this period of maximum efficiency is, has not been determined. (Miller, G. E., and Pilzecker, A., *Zur Lehre vom Gedächtnis*, Zeits. f. Psy, u. Physiol. d. Sinnesorgane, 1900, Ergänzungsband, Vol. 1) emphasize the fact that immediate reproduction is not as perfect as reproduction some minutes later. They explain this in terms of the so called "Perseverationstendenz". (See also Burnham, W. H., *Retractive Amnesia*, Am. Jour. of Psy. Vol. 14, 1903.) In the strong type, the dominant one, it

seems within a day, but with the weaker types the period is less. In general the auditory type shows a decided decrease the first day, while the visual is the reverse.

These conclusions are not conclusive, yet evidences are strong that it seems probable that most of them will stand the test of investigation upon each particular conclusion. The field was too broad for minute details, yet the method was thorough enough to locate some field for further investigation. It is claimed that the investigation has been done in a scientific manner and it has used means for carrying it on that are worthy of consideration of scientific men. The field laid open shows many problems for research and the conclusions reached deserve more consideration than the name of mere theories.

m	x	s	c	x
c	s	m	s	m
x	c	s	x	c
c	m	c	s	x

Fig. Ia

s	c
x	m

Fig. I. b.

Fig. IIa.

Fig. II. b.

	II	
	4	
	K	

Fig III



Fig 4.

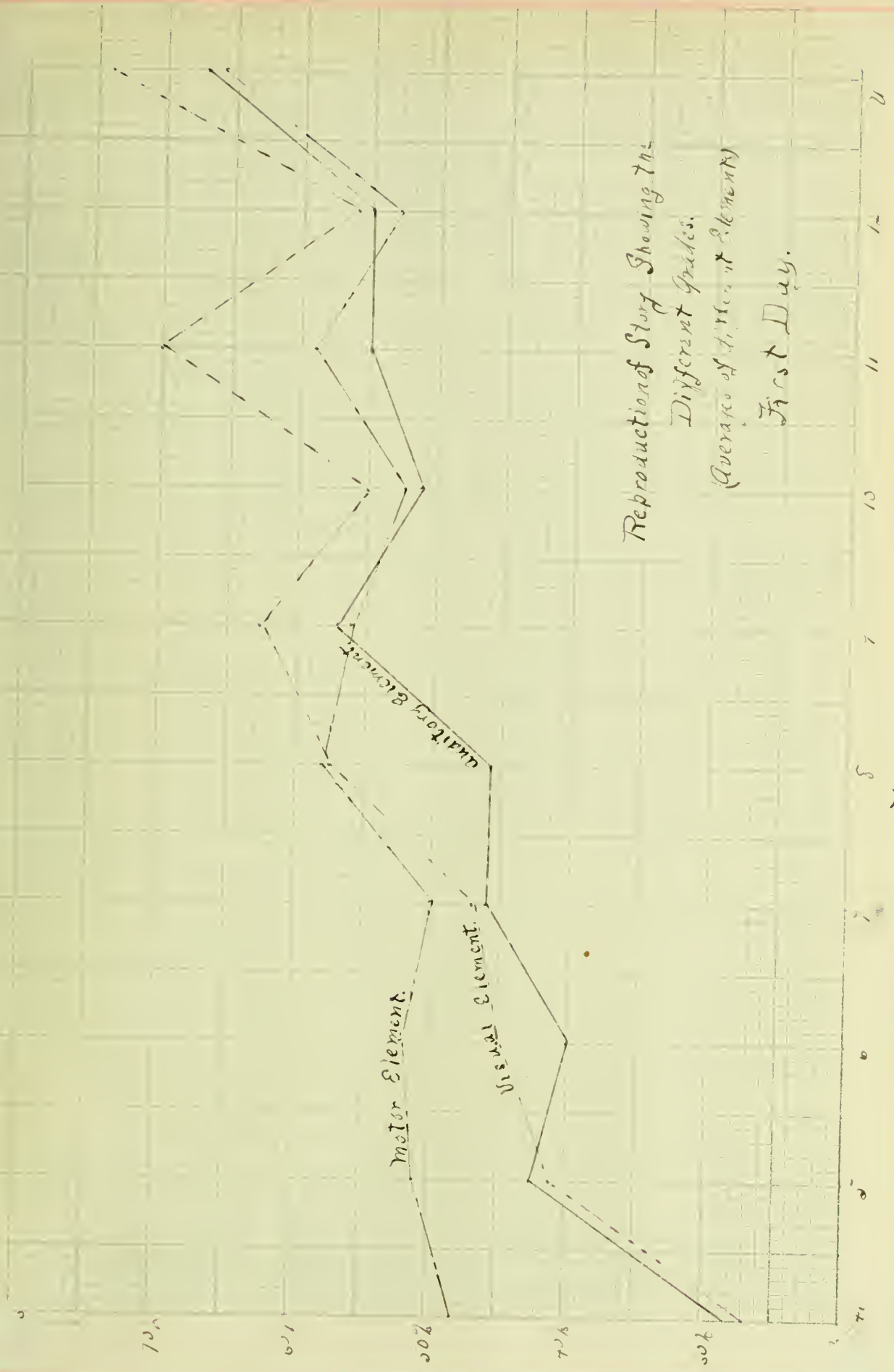


Fig. 5.

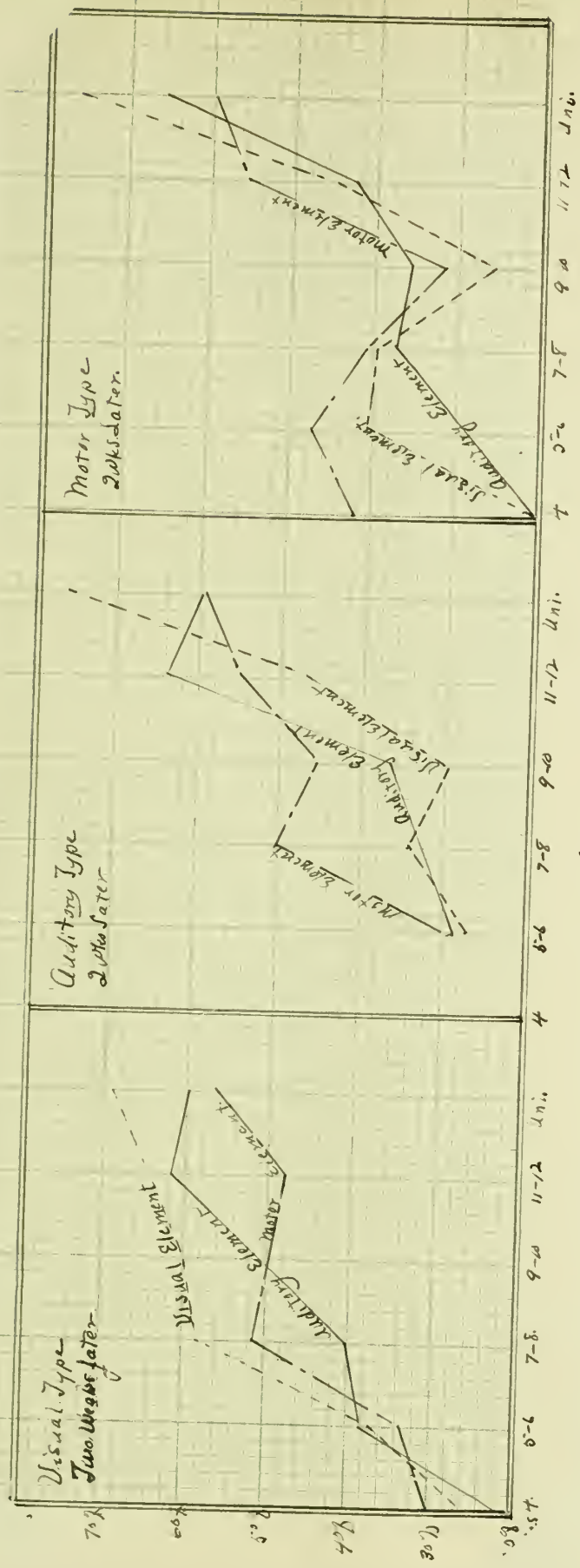


Plate continued.

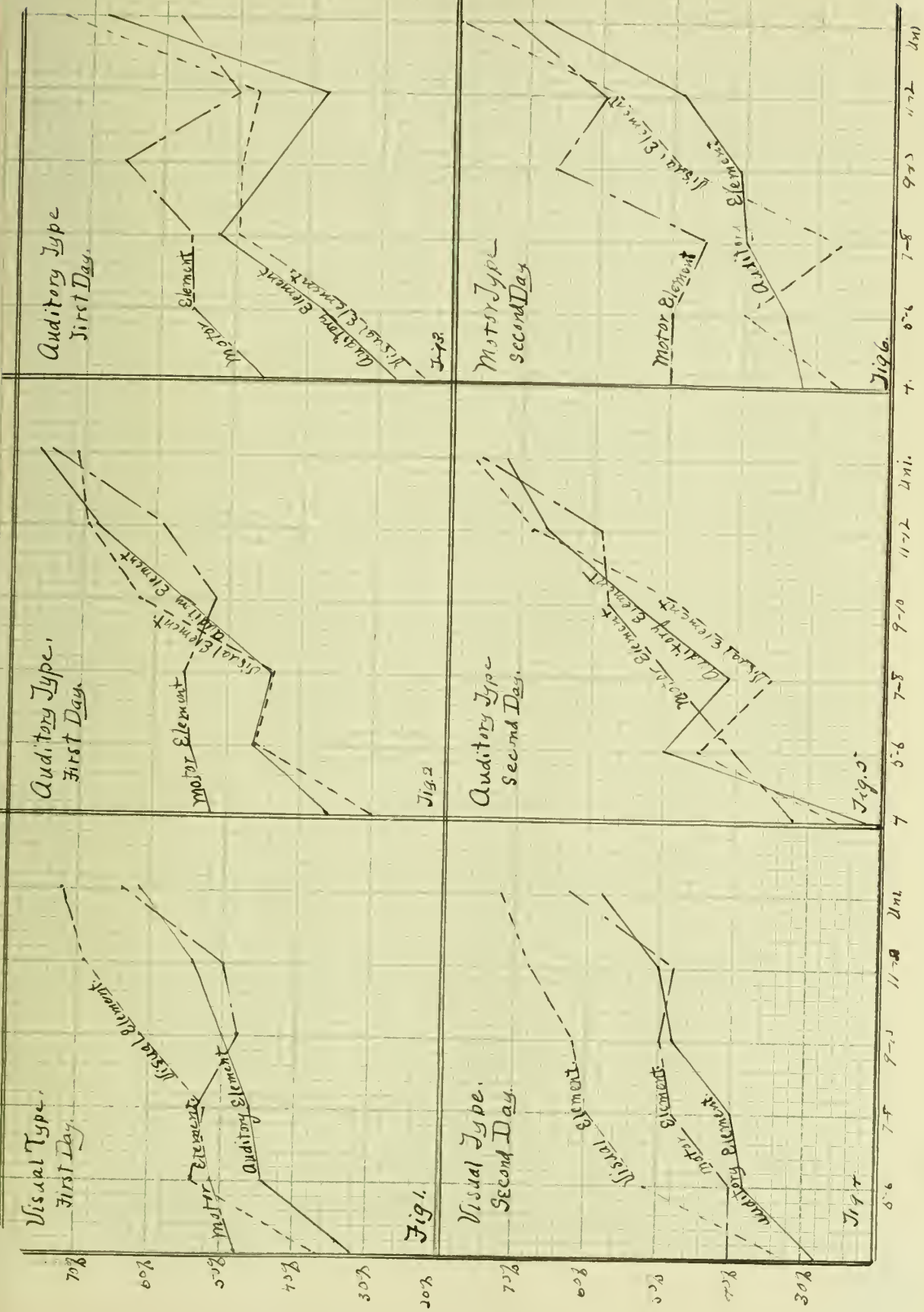
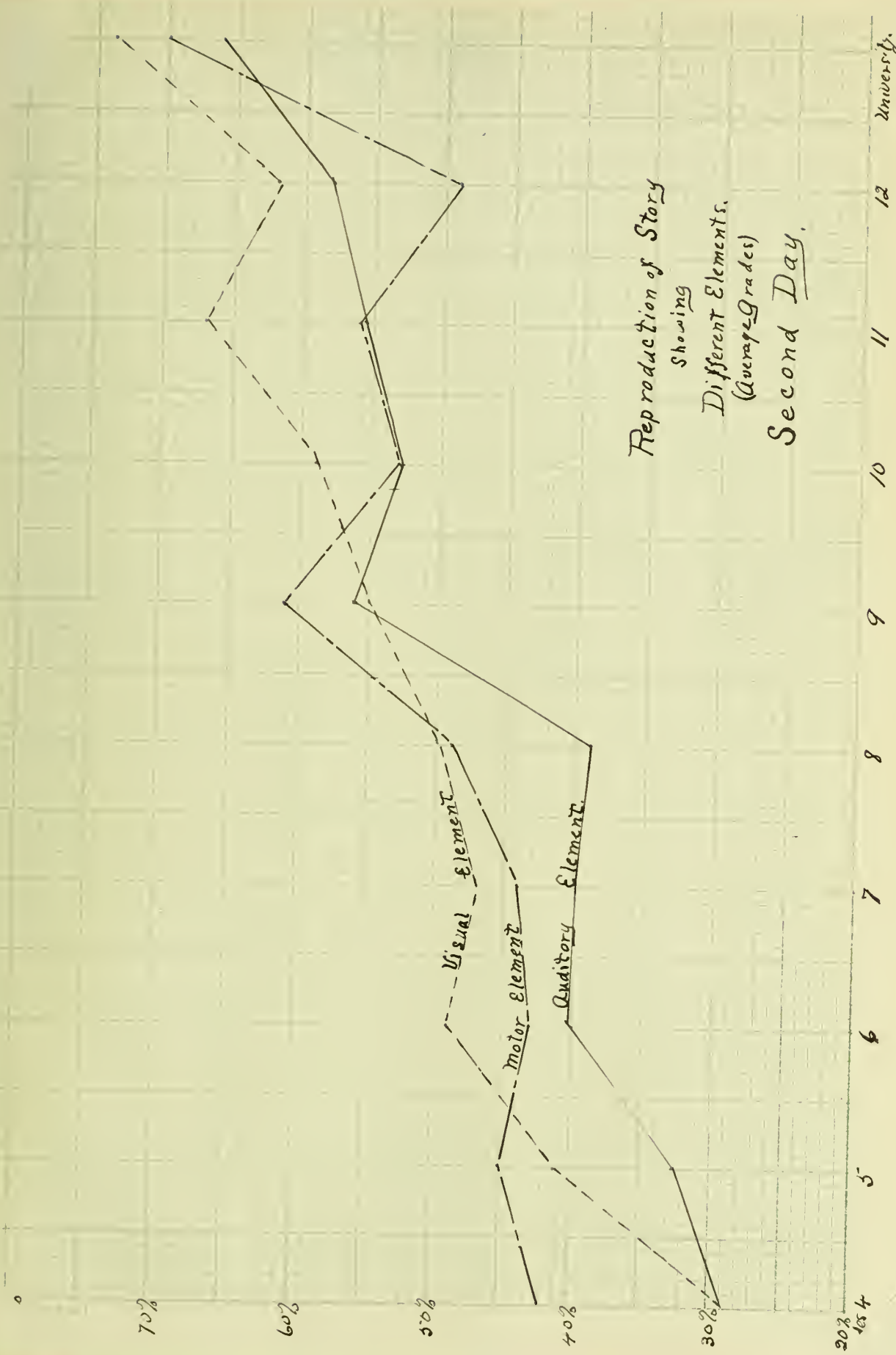


Plate showing Reaction of different types to different stimuli and the finding of the Imagery of these Types



Reproduction of Story
 Showing
 Different Elements.
 (Average Grades)
 Second Day.

University.

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Introduction

The first part of the report discusses the background and objectives of the study. It outlines the scope of the research and the methods used to collect and analyze the data. The second part presents the results of the study, including a detailed description of the findings and their implications. The final part of the report discusses the conclusions drawn from the study and offers suggestions for further research.

The results of the study show that there is a significant correlation between the variables being studied. This finding is consistent with previous research in the field and has important implications for the theory and practice of the discipline. The study also identifies several areas where further research is needed to clarify the relationships between the variables and to explore the underlying mechanisms.

In conclusion, the study has provided valuable insights into the relationship between the variables being studied. The findings have important implications for the theory and practice of the discipline and offer suggestions for further research. The study also identifies several areas where further research is needed to clarify the relationships between the variables and to explore the underlying mechanisms.

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Appendix.

1. These results seem to be not entirely in accord with Lay. (Führer ~~d~~urch den Rechtschreibunterricht. Wiesbaden, 1899) who concludes that motor processes are very valuable in memory. He considers vocalizing and writing of the utmost importance. In spelling he urges that the pupil vocalize and copy the word he is learning. This opinion is also held by Itscher. (Lay's Rechtschreibe Reform, Jahrbuch d. Verein für Wis. Päd. 32, 1900). Miss Smith, T.L. On Muscular Memory. Am. J. of Psy. 1896, Vol. VII, 453-490, likewise concludes that vocalizing is a great aid to memory.
2. On the other hand Hawkins, C.J. (Experiments on Memory Types. Psych. Rev., 1897, Vol. IV, 289-294) who presented visual and auditory words successively at the same rate to his subject, concluded that auditory impressions are better for children; visual for adults. Pohlmann, A. (Experimentelle Beiträge zur Lehre vom Gedächtnis. Berlin, 1906.) agrees with Hawkins that auditory presentation is more satisfactory for children when familiar words are used, but visual are more satisfactory when material is unfamiliar.

Story.

The other night Walter Brown had a thrilling adventure. He had gone to bed and was about asleep when a fire whistle blew loud and shrill. Instantly the horses and hose-cart came dashing by the pavement followed by a crowd of laughing boys. Again all was quiet and all he could hear was the tramp of a policeman on his beat and the sound of his club as he struck an iron lamp post on the corner. Again he was about asleep when he was aroused by the motorman's bell and the loud deep tones of the town clock as it struck twelve. Again all was quiet. He heard foot steps on the front porch, a low whistle, a scraping noise, and the sound of falling glass. Mr. Brown raised in his bed and bent forward to listen. Silently he put one foot out of bed, held it there a moment, then softly stepped on the floor and holding his breath, strode cautiously down the stairs. When he reached the landing he turned on the switch. Immediately the room was filled with light. In the middle of the room stood a burglar with a red beard, a black mask over his face, dark trousers spotted with mud, and a green bag in his hand. In the other hand he held a revolver, which glistened in the light. On the table was a pile of silver spoons just ready to be taken. Mr. Brown sprang toward the burglar, seized him, and a hand to hand fight ensued. He held the burglar tight around the waist, called for help and tried to keep from falling. The burglar pushed toward the door when the door instantly opened and in came two policemen who took the burglar, and Mr. Brown escaped without harm. This ended Mr. Brown's adventure.





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